Neutrino Factory Mercury Containment Concepts

V.B. Graves

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Outline

- Neutrino Factory cryostat layouts
- Hg jet and pool containment
- Future efforts
Neutrino Factory Cryostat 1 Concept

- Five superconducting magnets (SC1-SC5)
- Three hollow conductor resistive magnets (HC1-HC3)
- Iron plug
- Water-cooled tungsten-carbide shielding
- Mercury jet containment vessel / beam stop
Cryostat 1 Assembly & Maintenance

- Study II assumed main cryostat remotely assembled in cell due to component weights
  - Handling fully assembled cryostat would require 160-ton crane
- Concept to install components by rotating cryostat and lowering modules into it
- Assembly method shown probably not feasible due to connector issues
- Much more design effort needed to develop concept
Based on Study II Tables 3.13, 3.14
Dimensions in cm
NF Hg Jet Layout

V.B. Graves
ORNL
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Study II Mercury Containment Vessel

- Document gave cursory mention of mercury pool containment vessel but no mechanical detail.
- Development of 3D models gives new perspective and offers insight into real issues that will have to be resolved.
Alternative Vessel Drainage

• Penetrations through cryostat will complicate design and assembly
• End drain configuration may be preferred
Mercury Vessel Functions

- Jet and beam dumps
- Liquid and vapor containment barrier
  - Protects cryostat & shielding walls from contamination
- Hg splash mitigation
- Hg drainage
- Exit beam window
Mercury Vessel Features

- Upstream opening for nozzle (encloses nozzle)
- Hg overflow and vessel drains
- Air-space vent (not shown)
- Iron plug and downstream cryostat seals
- Downstream particle window
Containment Design Requirements

- Material compatible with high-field magnets
  - Must also withstand some number of full-power beam pulses with no Hg in vessel (accident scenario)
- Desire no replaceable components
- Provide support for Hg weight
  - ~80 liters, 1 metric ton in “short” configuration shown
- Sloped (1°-2°) for gravity Hg drain
- Overflow drain for 30m/s jet (2.4 lps)
- Vent for gas transfer
Splash Mitigation

- Study II assumed a particle bed of tungsten balls to minimize effects of jet entering pool
- Many other feasible concepts to accomplish this function
- Simulation/analytical studies may be useful to limit options
- Prototypic testing needed for comparison & final determination
Future Efforts

- **Follow-On Testing**
  - Given funding, would like to pursue design of a jet pool test bed using MERIT syringe pump
  - More prototypic nozzle configuration
  - Allow direct viewing of jet and splash
  - Replaceable splash mitigation hardware
  - Replaceable nozzles

- **Continue low-key effort to further the mercury system design**

- **Neutrino Factory International Design Study will provide a mechanism to further development of the main cryostat concept**
Summary

- 3D conceptual model of a Neutrino Factory mercury containment vessel has been developed
- Integration of this vessel into the enclosing cryostat will require further engineering
- Splash mitigation R&D will be required
- The IDS should provide a platform for a broader review of the entire system